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(54) **Method for reinforcing heat exchanger tube to header joints**

(57) A method for reinforcing heat exchanger tube to header joints comprises mutually joining a reinforcing plate that is smaller dimensionally than the dimensions of the header to the header, forming the tube holes (14, 15) Fig. 4 (not shown) in both plates (10, 11) simultaneously, and inserting the tube (16) ends into the holes and soldering them (17) in place.

Fig.6.

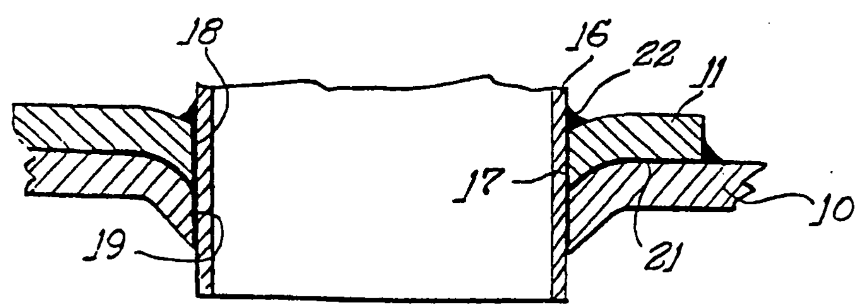

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Fig.1.

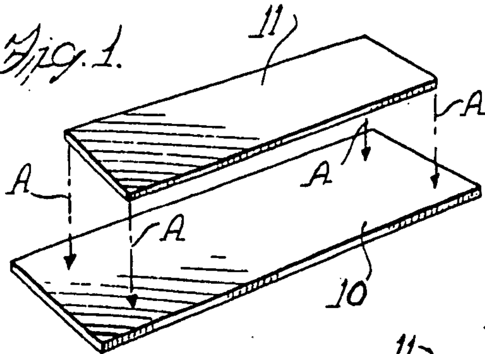


Fig.2.

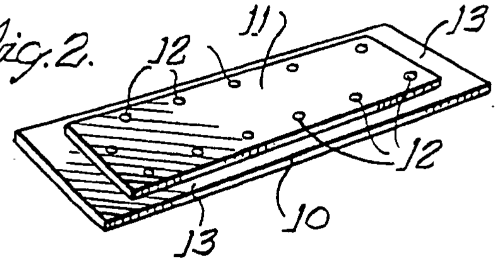


Fig.3.

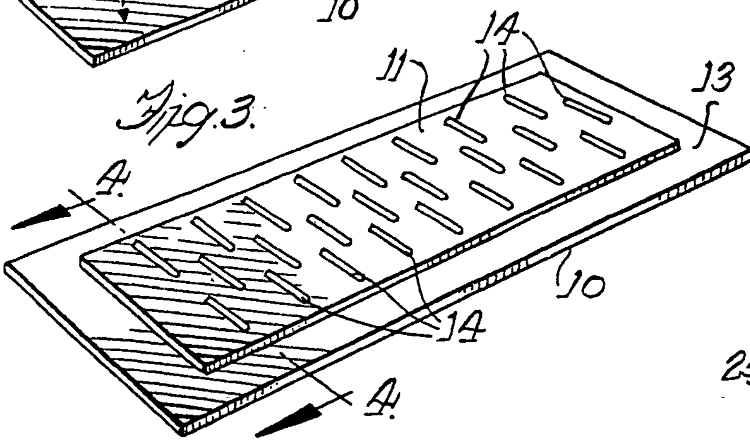


Fig.7.

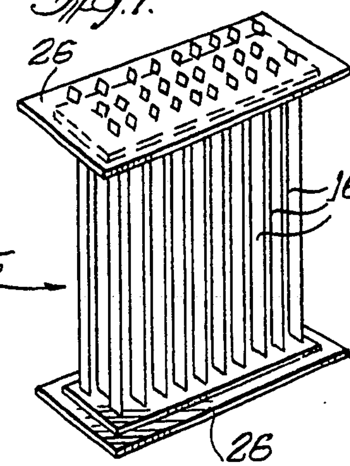


Fig.4.

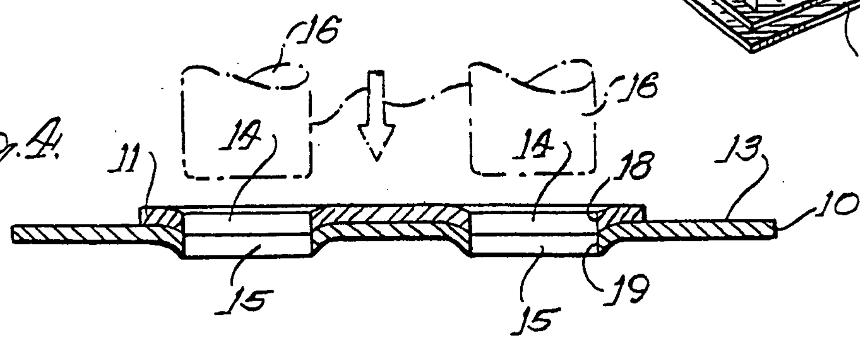


Fig.5.

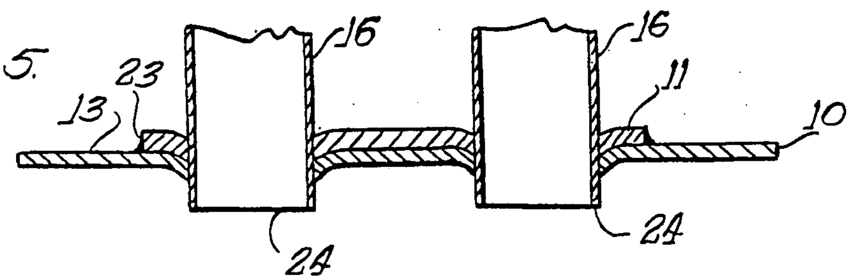


Fig.6.

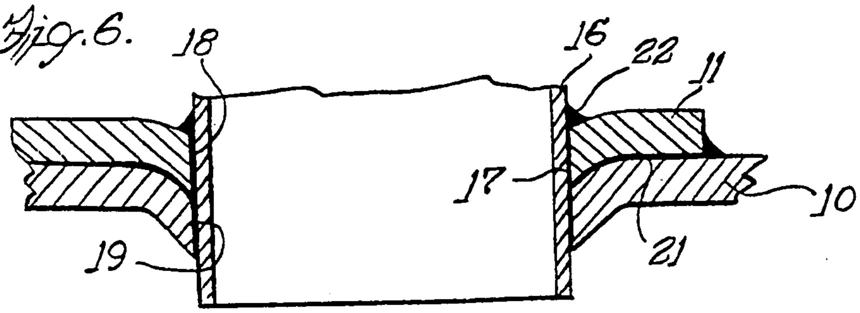


Fig.8.

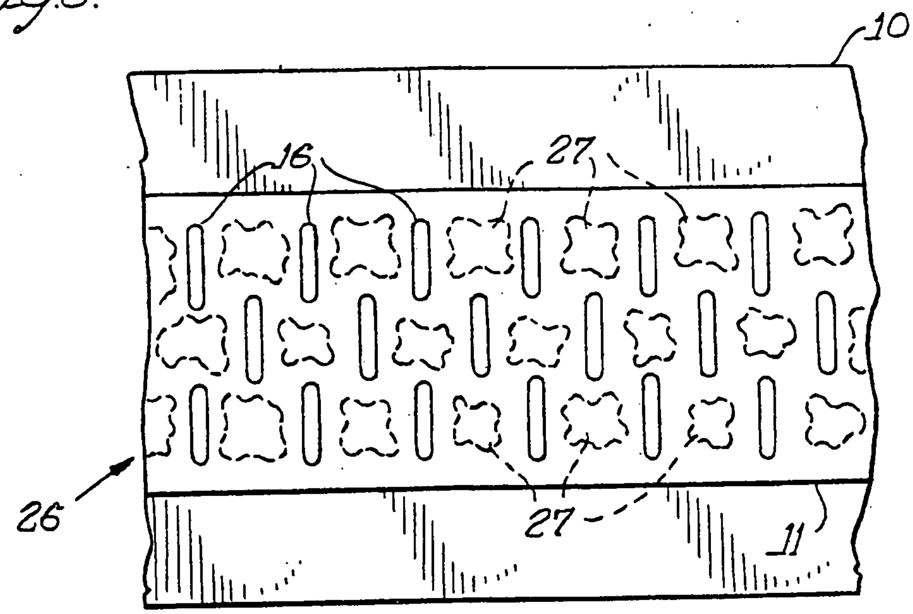


Fig.9.

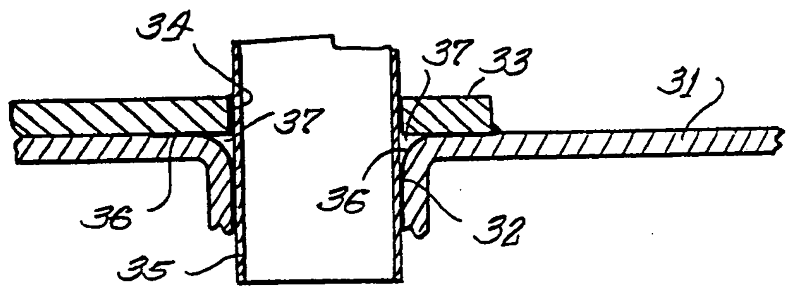
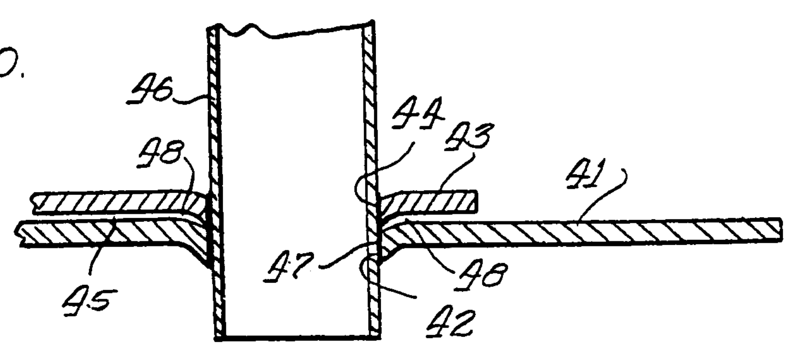


Fig.10.



SPECIFICATION

Method for reinforcing heat exchanger tube to header joints

Heat exchangers in the past have utilized reinforcement plates where the tube to header joints are unsatisfactory or the stresses exerted in the heat exchange structure are concentrated at the outer tube edge solder joints. Bolted radiator core assemblies have located reinforcement plates in the four corners of the core; these reinforcement being relatively short in length. Other assemblies require a long reinforcement plate or have used a reinforcement plate of substantially the same dimensions as the header plate so that the edges of both plates must be secured and sealed to the headers by bolting, etc.

The header and reinforcement plate tube holes are punched, lanced and/or form punched separately. The two parts are then placed together, aligned and joined by suitable means, such as spot welding, riveting and/or soldering. The tubes are then installed in the header assembly and soldered. These methods require complex tooling to duplicate results and have problems of mismatch where long reinforcements are made. These present reinforcements are not consistent in providing void free joints and require separate dies for the header and reinforcement plate. The present invention relates to an improved way of distributing the stresses that exist in the tube to header solder joints.

The present invention relates to a novel method of reinforcement of the tube to header joints in a heat exchanger assembly. High stresses develop in these joints due to vibration and also due to thermal stress development occurring from the differential expansion of the core and the heat exchanger structure. Essentially, this method requires a preliminary joining operation of a reinforcement plate to the tube header followed by a hole punching operation on the assembled plates to provide the tube holes, the insertion of the tubes thereinto and soldering of the tubes to the header and reinforcement plate. This method allows for complete flexibility in selecting various material thicknesses for both the header and reinforcement plate to suit the heat exchanger application and, at the same time, achieving a perfect mate between both plates. This flexibility is essential when matching the durability required by the heat exchanger where numerous thermal fluctuations are present requiring a thin header and a thick reinforcement plate. When the heat exchanger is subjected to high shock loadings, then a thick header and thick reinforcement plate are necessary. The changes can be accommodated with little or no tooling change.

The present invention also comprehends the provision of a reinforcement plate joined to the tube and header to provide reduced stresses in the solder joint at the outside tube outer edge. Essentially the invention (1) provides a higher solder joint bond area parallel to the longitudinal axis of the tube around the tube periphery; (2) stiffens the area onto which the reinforcement is placed, thus distributing the stresses more evenly around the tube solder joint and into adjacent tube joints; and (3) moves the stress concentrations at the weak solder joint at the outer tube edges into the strong header plate material at the outside edges of the reinforcement.

The present invention further comprehends the provision of a reinforcement plate joined to a tube header which eliminates mismatch of openings where long reinforcements are required, eliminates the use of complex tooling to duplicate results, and provides for an excellent solder draw and bond between all three components; namely the tube, tube header and reinforcement plate.

Further objects are to provide a construction of maximum simplicity, efficiency, economy and ease of assembly, and such further objects, advantages and capabilities as will later more fully appear and are inherently possessed thereby.

One way of carrying out the invention is described in detail below with reference to drawings which illustrate only one specific embodiment, in which:

Figure 1 is an exploded perspective view showing the alignment of a header and reinforcement plate to be joined in the present method.

Figure 2 is a perspective view of the header and reinforcement plate joined together.

Figure 3 is a perspective view of the joined plates with the tube openings punched therein.

Figure 4 is an enlarged cross sectional view taken on the line 4—4 of Figure 3.

Figure 5 is a cross sectional view similar to Figure 4, but with the tubes inserted into the openings.

Figure 6 is an enlarged cross sectional view similar to Figure 5, but showing a solder joint for a tube.

Figure 7 is a perspective view of a core for a heat exchanger having a plurality of tubes extending between and joined to reinforced headers.

Figure 8 is a top plan view of the reinforced header and tubes of Figure 7.

Figure 9 is a cross sectional view of a presently utilized reinforcement joint having a lanced header and punched reinforcement.

Figure 10 is a cross sectional view of another presently used reinforcement joint with a formed-punched header and reinforcement.

Referring more particularly to the disclosure in the drawings wherein is shown an illustrative embodiment of the present invention, Figure 1 discloses the first step in the formation of a reinforced tube header of the present invention where a tube header 10 cut to required size and adapted to be utilized in a tube and fin core for a heat exchanger (not shown) has a reinforcement plate 11 cut to required size and aligned thereon as shown by arrows A. Once positioned, the tube header plate and reinforcing plate are spot welded, welded, soldered, brazed or otherwise joined together at a plurality of locations 12

approximately 2″ to 3″ apart adjacent the periphery of the plate 11; the header plate 10 having a border 13 exposed by the plate 11 adapted to be clamped or otherwise secured to an inlet or outlet tank of a heat exchanger.

The assembled tube header-reinforcement plate is then placed in a form-punch or punch single hit die to produce the tube hole pattern (see Figure 3) having the rows of openings 14 and 15 through the reinforcing plate 11 and tube header 10, respectively. This die may punch all of the openings simultaneously or progressively as more clearly shown in Figure 4. As seen in Figure 5, the tubes 16 of the core are inserted into the openings 14, 15 and solder is applied. The solder draw is excellent to provide void free joints 17 at the tube and the reinforcement plate-tube header outer edges 18, 19 respectively. As seen in Figure 6, not only is the solder joint 17 void free but a small quantity of solder 21 is drawn between the reinforcement plate 11 and header 10. Also, solder 17 is drawn between reinforcement plate edges, header edges, and tube 18, 19 and 16, respectively, and a bead 22 of solder forms at the depressed edge 18 of the plate 11.

The distance between the outer edge 23 of the reinforcement plate 11 and the tube tip 24 has a minimum acceptable dimension. This is determined so that there is no distortion of the reinforcement plate 11 producing a gap between the header 10 and reinforcement 11. Figure 7 discloses an assembled tube core 25 having reinforced headers 26 at each end to be secured to the inlet and outlet tanks of a heat exchanger. Figure 8 discloses the finished header 26 with the tubes soldered therein. Voids 27 are present between the header and reinforcement plates and between the tubes 16 but the structural performance of the header is not effected.

The above described method overcomes many problems associated with producing effective reinforced joints. It eliminates the use of complex tooling for duplication of results and provides for complete flexibility in changing material thicknesses without die changes. As shown in Figures 9 and 10, presently used types of reinforcement are not consistent in providing void-free joints. As seen in Figure 9, the header 31 has lanced openings 32 and the reinforcement plate 33 has punched openings 34. After the hole forming operations, the plates are aligned and joined by spot welding, riveting and/or soldering, the tubes 35 inserted in the openings and soldered. As seen, the solder 36 does not provide a void-free joint, as evidence by the voids 37. As above noted, two separate dies are required to produce the tube header and reinforcement plate. Also, stock thickness on the header cannot be varied without a die change. If a progressive die is used to punch the header and/or reinforcement tube holes, serious mismatch may occur in producing a long reinforcement. To eliminate the mismatch, piercing small sections together will solve the problem, but it is cumbersome.

In Figure 10, both the header and reinforcement plate openings are formed by the same die. As shown, the header 41 has form-punched openings 42 and the reinforcement plate 43 has form-punched holes 44. When joined together, the header 41 and reinforcement plate 43 do not mate, resulting in gaps 45 therebetween. When the tube 46 is inserted and solder 47 applied, voids 48 may be possible.

CLAIMS

1. A method of reinforcing heat exchanger tube to header joints, comprising the steps of cutting a tube header to size and providing a reinforcing plate of smaller dimensions than the header, joining the reinforcing plate to the tube header, forming tube opening through the joined plates, inserting a tube into each opening and applying solder to the joint area.

2. The method as set forth in Claim 1, in which the tube header and reinforcement plate are joined by spot welding, soldering, welding or brazing.

3. The method as set forth in Claim 1, wherein the tube openings are formed simultaneously in the header and reinforcement plate.

4. The method as set forth in Claim 3, wherein the openings are punched in the plates.

5. The method as set forth in Claim 3, wherein the openings are form-punched in the plates.

6. The method as set forth in Claim 1, in which an excellent solder draw and bond is achieved between the tube and plates.

7. The method as set forth in Claim 1, wherein the header has a peripheral border beyond the reinforcement plate adapted to be secured to a header tank in a heat exchanger.

8. The method as set forth in Claim 1, in which the plates are joined by spot welding at 2 to 3 inch intervals adjacent the periphery of the reinforcement plate to prevent excessive gap therebetween.

9. The method as set forth in Claim 1, wherein complete flexibility is achieved in the selection of various material thicknesses for both the header and reinforcement plate to suit the heat exchanger application.

10. A method as set forth in Claim 3, wherein a preferred mating between the header and reinforcement plate of various material thicknesses is achieved with little or no tooling change.

11. A method of reinforcing heat exchanger tube to header joints substantially as hereinbefore described with reference to the accompanying drawings.

12. A heat exchanger including tube to header joints reinforced by the method of any preceding claim.

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